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(21) International Application Number: PCT/EP97/04574 (22) International Filing Date: 15 August 1997 (15.08.97) (30) Priority Data: 96306534.7 9 September 1996 (09.09.96) EP (34) Countries for which the regional or international application was filed: GB et al. (71) Applicant (for AU BB CA GB GH IE IL KE LC LK LS MG MW NZ SD SG SL SZ TT UG ZW only): UNILEVER PLC (GB/GB); Unilever House, Blackfriars, London EC4P 4BQ (GB). (71) Applicant (for all designated States except AU BB CA GB GH IE IL KE LC LK LS MG MW NZ SD SG SL SZ TT UG ZW): UNILEVER N.V. [NL/NL]; Weena 455, NL-3013 AL Rotterdam (NL).	(72) Inventors: BINLEY, Gary, Norman; 15 Raven Drive, Barton Seagrave, Kettering, Northampton NN15 6SD (GB). BURMESTER, Sabina, Silvia, Hanel; 71 Woodlark Road, Cambridge CB3 0HT (GB). CHIARANUSSATI, Nuj; 23/F Tower 2, Clovelly Court, 12 May Road, Hong Kong (CN). WINCH, Paul, Jonathan; 13457 Velp Avenue, Suamico, WI 54173 (US). WIX, Loyd; 93 Hayway, Rushden, Northamptonshire NN10 6AQ (GB). (74) Agent: KIRSCH, Susan, Edith; Unilever plc, Patent Division, Colworth House, Sharnbrook, Bedford MK44 1LQ (GB). (81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report.	
(54) Title: FROZEN AERATED ICE CREAM FREE OF EMULSIFIER AND PREPARATION THEREOF		
(57) Abstract A frozen aerated product having no added emulsifier and preferably no added stabiliser and having a fat content of from 1 to 6 % which satisfies the following conditions: (a) % DF greater than or equal to [0.6 * %F]; (b) % ML100 less than or equal to 100 % - [5.35 * %F]; and (c) an air cell size distribution such that the mean air cell size is less than 40 µm with a standard deviation of less than 20 µm; wherein DF = destabilised fat, F = fat, ML100 = mass loss after 100 minutes.		

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FROZEN AERATED ICE CREAM FREE OF EMULSIFIER AND PREPARATION THEREOF

Technical Field of the Invention

5 The invention relates to a high quality frozen aerated product, particularly an ice cream product and the manufacture thereof, wherein the frozen aerated product has a low fat content and requires no addition of emulsifiers.

10 Background to the Invention

Traditionally frozen aerated products such as ice cream products contain approximately 8-12% fat in addition to stabilisers and emulsifiers in order to provide the desired
15 quality product. However, it is now preferred to provide such products which are low fat and without additives. To date products provided which are low fat and without added stabilisers and emulsifiers have been inferior in quality in that they are fast melting, have a low percentage of
20 destabilised fat, and are unstable to heat shock and hence quickly become very icy. Furthermore, such products have a reduced creaminess perception.

Clearly it would be advantageous to be able to provide a
25 low fat product having no added emulsifiers, and preferably no added stabilisers or emulsifiers which nevertheless retains its high quality.

Frozen aerated products such as ice cream are usually
30 produced by a continuous process comprising the following steps:

- a) homogenising of ingredients
- b) pasteurisation
- c) cooling
- 35 d) freezing and aeration
- e) extrusion
- f) (optional) deep freezing

Normally the homogenisation step takes place in a first vessel, followed by continuous pasteurisation followed by cooling. The mixture is then transferred to a freezer, for example a scraped surface heat exchanger where the product is frozen to a temperature of approximately -6°C followed by quiescent cooling in a hardening tunnel.

The applicants have surprisingly found that if the product is subjected to cooling and shearing in a screw extruder prior to extrusion and any optional deep freezing, a high quality low fat product may be prepared even in the absence of emulsifiers and preferably also in the absence of stabilisers.

Screw extruders such as single screw and twin screw extruders are widely used in the chemical industry for example in the production of plastics. It has also been proposed to use single screw or twin screw extruders in the freezing of ice-cream, see for example EP 561 118 and EP 401 512.

EP 713 650 discloses a method for manufacturing frozen aerated products in which the composition to be frozen is mixed, aerated and cooled to a temperature equal or less than -8°C prior to extrusion in a single twin screw device.

However, to date it has not been recognised that such screw extruders can advantageously be used to prepare a high quality frozen aerated product having a low fat content and no added emulsifiers or stabilisers.

Disclosure of the Invention

Accordingly the invention provides a frozen aerated product comprising;

- 5 (i) 1 to 6% fat
(ii) 0% emulsifier
(iii) 0 to 1.0% stabiliser
which satisfies the following conditions:

- 10 (a) % DF greater than or equal to $[0.6 * \%F]$;
(b) % ML100 less than or equal to $100\% - [5.35 * \%F]$;
and
(c) An air cell size distribution such that the mean
15 air cell size is less than $40 \mu\text{M}$ with a standard
deviation of less than $20 \mu\text{M}$;

wherein DF = destabilised fat
F = fat
20 ML100 = mass loss after 100 minutes

Preferably the product has from 0 to 0.5% stabiliser, more preferably from 0 to 0.25 % stabiliser, even more preferred from 0 to 0.15% stabiliser, most preferred 0% stabiliser.

25 Preferably the product has 2% fat, most preferably 3% fat.
By fat is meant triglycerides and not mono- or di-glycerides.

30 Preferably the product has an air cell size distribution such that the mean air cell size is less than $25\mu\text{M}$, more preferably less than $20\mu\text{M}$.

35 A convenient process for the preparation of the frozen aerated product according to the invention comprises subjecting the product to be frozen to shear forces and cooling in a screw extruder prior to extrusion and optional

deep freezing.

The screw extruder can be either a single or multiple screw extruder, preferably however a single or twin screw extruder is used.

Preferably the product is extruded at a temperature of from -10°C to -30°C, more preferably from -10°C to -25°C, most preferably -10°C to -15°C.

The screw extruder may be employed after the conventional freezing and aeration step within for example a scraped surface heat exchanger. Alternatively all steps prior to extrusion, including if desirable homogenisation and pasteurisation, may be conducted within the screw extruder as described in either EP 713 650 or our copending European patent application EPA 96302718.0

Frozen aerated products according to the invention have been shown to have an increased perception of fat, characterised by increases in creamy texture, thickness, smoothness, initial smoothness and reduction of ice crystal quantity in mouth and ice crystal size in mouth.

The percentage destabilised fat was measured using a solvent extraction technique. 10g of ice cream was melted for 4 hours at ambient temperature before extraction with petroleum solvent. The solvent was evaporated and the extracted destabilised fat was weighed, this was expressed as a percent of the weight of the total fat in the ice cream.

The percentage mass loss after 100 minutes was determined by measuring the weight of melted ice cream every minute over the required time period.

The air cell distribution was determined using low

temperature scanning electron microscopy (SEM).

5 The mean air cell size measured for the products of the invention is thought to be important for providing products having a creamy texture. Conventionally prepared ice cream, which is stabilised and emulsified will have a mean air cell size of from 60 to 100 μ M.

10 Preferably the frozen aerated product of the invention is a milk or fruit based frozen aerated confection such as ice cream, frozen yoghurt, sherbet, sorbet, and frozen custard.

15 Suitable ingredients and their preferred levels for such a frozen aerated confection are for example: Ice cream/custard: milk fat 1-6 wt%, milk solids non fat 2 to 15 wt%, sugar or other sweeteners 0.01 to 35 wt%, flavours 0-5 wt%, water 30 to 85 %wt.

20 Any stabiliser used in ice cream is suitable, for example Locust Bean Gum (LBG), Carrageenan, Guar gum, gelatin, CMC (Carboxy methyl cellulose) gum, pectin, algin products, and mixtures thereof.

ExamplesExample 1

5 An ice cream mixture having the following formulation:

 4.5% Fat
 13.91% Skimmed Milk Powder
 16.76% sucrose
 0.4% flavour
10 Water to 100%

 was prepared in the conventional way and initially frozen
 in a standard ice cream freezer (scraped surface heat
 exchanger, SSHE) to a temperature of -7.6°C. Air was added
15 to the mix in a ratio of 1:1.

 The outlet of the SSHE was connected by pipework to a
 single screw extruder with a refrigerated jacket which
 continued to freeze the ice cream to a temperature of
20 < -10°C. The single screw extruder had the following
 geometry:

Barrel length	0.75m
Barrel diameter	0.2m
Screw pitch	0.135m (2 start)
25 Screw Channel depth	15 mm

 The single screw extruder was controlled to maintain a
 constant inlet pressure of 7 barg and a torque on the screw
 of 1500 Nm. The outlet pressure was 8 barg. The flow rate
30 was 250 L/hr. During production the torque level was
 increased and when the torque reached 1500Nm the extruded
 ice cream changed colour becoming whiter.

 An ice cream product was obtained which was emulsifier and
35 stabiliser free having 10.3% destabilised fat, 72% mass
 loss after 100 minutes, and the mean air cell size was
 20µM.

Furthermore, the ice-cream was of high quality having an excellent creamy texture and smoothness. A trained sensory panel perceived this low fat formulation to be as creamy as a commercial sample prepared in the same way having an identical formulation except that the fat content was 12%.

Example 2

An ice cream mixture having the following formulation:

10	1.0% Fat
	14.76% Skimmed Milk Powder
	17.37% sugars
	0.22% stabiliser
	0.4% flavour
15	Water to 100%

was prepared in the conventional way and initially frozen in a standard ice cream freezer (scraped surface heat exchanger, SSHE) to a temperature of -6.2°C . Air was added to the mix in a ratio of 1:1.

The outlet of the SSHE was connected by pipework to a single screw extruder with a refrigerated jacket which continued to freeze the ice cream to a temperature of $< -10^{\circ}\text{C}$. The single screw extruder had the following geometry:

	Barrel length	0.75m
	Barrel diameter	0.2m
	Screw pitch	0.135m (2 start)
30	Screw Channel depth	15 mm

The single screw extruder was controlled to maintain a constant inlet pressure of 7 barg and a torque on the screw of 1800 Nm. The outlet pressure was 8 barg. The flow rate was 250 L/hr.

An ice cream product was obtained which was emulsifier free

having 0.91% destabilised fat, 91.8% mass loss after 100 minutes, and the mean air cell size was 17.6 μ M, with a standard deviation of 9.9 μ M.

5 Example 3

An ice cream mixture having the following formulation:

10 4.5% Fat
 13.91% Skimmed Milk Powder
 16.76% sucrose
 0.22% stabiliser
 0.4% flavour
 Water to 100%

15 was prepared in the conventional way and initially frozen in a standard ice cream freezer (scraped surface heat exchanger, SSHE) to a temperature of -6.2°C. Air was added to the mix in a ratio of 1:1.

20 The outlet of the SSHE was connected by pipework to a single screw extruder with a refrigerated jacket which continued to freeze the ice cream to a temperature of < -10°C. The single screw extruder had the following geometry:

25 Barrel length 0.75m
 Barrel diameter 0.2m
 Screw pitch 0.135m (2 start)
 Screw Channel depth 15 mm

30 The single screw extruder was controlled to maintain a constant inlet pressure of 7 barg and a torque on the screw of 1800 Nm. The outlet pressure was 8 barg. The flow rate was 250 L/hr.

35 An ice cream product was obtained which was emulsifier free having 4.86% destabilised fat, 35% mass loss after 100 minutes, and the mean air cell size was 18.9 μ M, with a

standard deviation of $12.8\mu\text{M}$.

Example 4

5 An ice cream mixture having the following formulation:

2.0% Fat
14.52% Skimmed Milk Powder
17.19% sugars
0.22% stabiliser
10 0.4% flavour
Water to 100%

was prepared in the conventional way and initially frozen
in a standard ice cream freezer (scraped surface heat
15 exchanger, SSHE) to a temperature of -6.2°C . Air was added
to the mix in a ratio of 1:1.

The outlet of the SSHE was connected by pipework to a
single screw extruder with a refrigerated jacket which
20 continued to freeze the ice cream to a temperature of
< -10°C . The single screw extruder had the following
geometry:

Barrel length	0.75m
Barrel diameter	0.2m
25 Screw pitch	0.135m (2 start)
Screw Channel depth	15 mm

The single screw extruder was controlled to maintain a
constant inlet pressure of 7 barg and a torque on the screw
30 of 1800 Nm. The outlet pressure was 8 barg. The flow rate
was 250 L/hr.

An ice cream product was obtained which was emulsifier free
having 1.23% destabilised fat, 89.3% mass loss after 100
35 minutes, and the mean air cell size was $18.4\mu\text{M}$, with a
standard deviation of $12.3\mu\text{M}$.

CLAIMS

1. A frozen aerated product comprising:

- 5 (i) 1 to 6% fat
(ii) 0% emulsifier
(iii) 0 to 1.0% stabiliser
which satisfies the following conditions:

- 10 (a) % DF greater than or equal to $[0.6 * \%F]$;
(b) % ML100 less than or equal to $100\% - [5.35 * \%F]$;
and
(c) An air cell size distribution such that the mean
air cell size is less than $40 \mu\text{M}$ with a standard
15 deviation of less than $20 \mu\text{M}$;

wherein DF = destabilised fat
F = fat
ML100 = mass loss after 100 minutes

- 20 2. A frozen aerated product according to claim 1 wherein
the product comprises from 0 to 0.5%, preferably 0 to
0.25% most preferably from 0 to 0.15% stabiliser.
- 25 3. A frozen aerated product according to claim 1 or 2
wherein the product comprises 0% stabiliser.
- 30 4. A process for the preparation of a frozen aerated
product according to any preceding claim wherein the
product to be frozen is subjected to shear forces and
cooling in a screw extruder prior to extrusion and
optional deep freezing.
- 35 5. A process according to claim 4 wherein the product to
be frozen is initially cooled to approximately -6°C in
a freezer before transferring into the screw extruder.

6. A process according to claim 5 wherein the freezer is a scraped surface heat exchanger.
- 5 7. A process for the preparation of a frozen aerated product according to any one of claims 1 to 3 comprising the steps of
- (a) homogenising of ingredients;
 - (b) pasteurisation;
 - 10 (c) cooling;
 - (d) freezing and aeration;
 - (e) extrusion; and
 - (f) (optional) deep freezing;
- 15 wherein steps (a) to (d) are conducted in a screw extruder.
8. A process according to any one of claims 4 to 7 wherein the screw extruder is a single screw extruder.
- 20 9. A process according to any one of claims 4 to 7 wherein the screw extruder is a twin screw extruder.
- 25 10. A process according to any one of Claims 4 to 7 wherein the product is extruded at a temperature of from -10°C to -30°C, preferably -10°C to -25°C, most preferably -10°C to -15°C.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/EP 97/04574

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A23G9/20 A23G9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A23G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP 0 351 476 A (GOAVEC) 24 January 1990 see column 2, line 34-36; claims; examples 1-6	1-6,8
Y	see column 5, line 44 - column 6, line 7 see column 1, line 1 - line 52	7,10
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	WO 92 11769 A (THE PILLSBURY CORP.) 23 July 1992 see claims; examples 1,2,6 ---	1-5,10
Y	EP 0 713 650 A (NESTLE) 29 May 1996 cited in the application see the whole document ---	1,4-6, 8-10
Y	EP 0 401 512 A (F. ROGGE ET AL.) 12 December 1990 see column 3, line 53 - column 4, line 17 see column 7, line 30-42 see page 4, column 49-54 see column 5, line 48 - column 6, line 33 ---	1,4-6, 8-10
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Information on patent family members

International Application No

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